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<u>Application No.</u>	<u>Country of Origin</u>	<u>Filed</u>
9901667.7	UNITED KINGDOM	January 26, 1999

Respectfully submitted,

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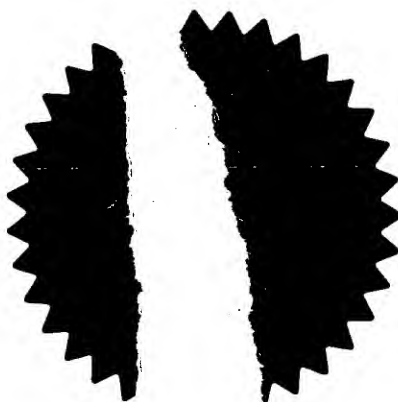
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Cardiff Road  
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1. Your Reference SG/P7503GB

2. Patent application number  
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26 JAN 1999 9901667.7

3. Full name, address and postcode of the or of each applicant (underline all surnames)

IMPERIAL CHEMICAL INDUSTRIES PLC

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Patents ADP number (if you know it)

935003

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

4. Title of the invention

LUBRICANT COMPOSITION

5. Name of your agent (if you have one)

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Patents ADP number (if you know it)

323001

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Country

Priority application  
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7896887001  
Date of filing  
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
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Claim(s)	1
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Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)

Request for preliminary examination and search (*Patents Form 9/77*)

Request for substantive examination (*Patents Form 10/77*)

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11. I/We request the grant of a patent on the basis of this application.

Signature

W.H. Geary, Greenen

Date

26.01.99

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# LUBRICANT COMPOSITION

This invention relates to a lubricant composition and in particular to a lubricant composition having an anti-deposition effect which is especially useful for the lubrication of refrigeration compressors. The invention also relates to a refrigeration system containing a refrigerant and a lubricant composition.

Conventional refrigeration systems typically have a compressor, a condenser, an expansion device and an evaporator linked to form a loop in which a refrigerant circulates and is successively condensed and evaporated so as to provide a refrigeration effect. Various types of compressor are employed in refrigeration systems including reciprocating, scroll, rotary and screw compressors and are selected according to the particular application. The compressor contains moving parts which are lubricated during use. The expansion device in refrigeration systems generally contains an area of constricted flow of refrigerant and may be, for example a capillary tube or an expansion valve.

A range of different materials are used in the construction of the components of a refrigeration system including metals and plastics materials. Other materials such as oils may be used in the assembly of the hardware of such systems and the components of the refrigerant working fluid especially additives may be susceptible to thermal or hydrolytic decomposition. During use and through wear, some of these materials may be present in the refrigeration loop and be carried around the system by the flow of refrigerant as unwanted residues. Other unwanted residues may also be introduced through servicing or the repair of refrigeration systems or in retrofitting new refrigerant or lubricant to the system once it has been used. In particular plastics materials, paraffinic materials, poly-alpha-olefins, silicone oils and carbonaceous materials

especially high molecular weight and non polar materials may be found as unwanted residues in the refrigeration loop. Such materials may be deposited in the refrigeration system especially in areas of constriction, and cause  
5 blockages and trap additional materials, for example particulate matter. Deterioration in performance and in extreme cases, system failure may occur due to such blockages.

10 In general, there are two types of refrigeration system, first, systems in which the lubricant and refrigerant are present as a mixture and circulate around the refrigeration system as such, for example in automotive refrigeration systems, and secondly, systems in which the  
15 refrigerant circulates in the system and the lubricant is present in a sump in the compressor, for example open and closed hermetic refrigerators and so-called industrial and commercial refrigerators. In the second case the system is designed to avoid or at least minimise the lubricant being  
20 carried from the compressor sump into the refrigeration loop although in practice, this typically occurs to a certain extent due to the entrainment of the lubricant into the refrigerant gas. Once lubricant is carried into the refrigeration loop it is necessary that it be transported  
25 around the system and deposited back in the sump otherwise reduced refrigeration effectiveness may result and problems due to a reduced level of lubricant in the sump may be encountered.

30 For many years, chlorofluorocarbons, for example dichlorodifluoromethane (R-12), have been used as refrigerants but have been implicated in the destruction of the ozone layer. Following the Montreal Protocol of 1987, such materials are being phased out and are being replaced  
35 by hydrochlorofluorocarbons on a temporary basis and also by hydrofluorocarbons. In particular, 1,1,1,2-tetrafluoroethane (R-134a) has found widespread use as a replacement refrigerant for R-12. HFC and HCFC



refrigerants both containing hydrogen are generally more polar than the chlorofluorocarbon refrigerants. This has exacerbated problems caused by the presence of unwanted residues in refrigeration systems, especially when HFC refrigerants are employed, as such materials typically have lower solubility in polar refrigerants than in CFC refrigerants.

The problem of blockage due to the presence of foreign bodies in the recirculating refrigerant has hitherto been addressed by modifying the mechanical design of the expansion device, for example capillary tubes in which the cooler part of the device has a larger diameter so as to reduce the likelihood of deposition of foreign bodies. Attempts have also been made to reduce the level of foreign bodies which may be incorporated into the system during manufacture. Refrigeration systems having hermetic compressors may be especially prone to these problems due to the level of foreign material present in the compressor motor. These approaches have the general drawback of requiring evaluation and testing of the refrigeration system as new materials of construction may need to be employed and have met with only limited success.

We have now found that by incorporating a component having an anti-deposition effect into the refrigeration system, problems associated with the presence of unwanted residues such as capillary blockage may be reduced or avoided. Further, we have found that a component having amphiphilic properties provides a suitable anti-deposition effect.

Accordingly a first aspect of the invention provides a lubricant composition comprising a lubricant and an amphiphilic anti-deposition component. A second aspect of the invention comprises a refrigeration lubricant composition for use in a refrigeration system with a

hydrogen-containing refrigerant comprising a synthetic lubricant and an amphiphilic anti-deposition component.

5 We have found that compositions according to the invention enhance the transport characteristics of unwanted residues, and so reduce deposition and/or aid removal of deposits for example by solubilising or dispersing the residues in the flow of the refrigerant and lubricant around the refrigeration system.

10

The refrigerant is suitably a hydrofluorocarbon (HCFC) refrigerant, a hydrofluorocarbon (HFC) refrigerant, or a blend of refrigerants containing at least one HFC, HCFC or both. Suitably the refrigerant does not contain chlorine atoms, thus the refrigerant is preferably consists essentially of only HFC refrigerant. HCFC's and HFC's contain at least one atom of carbon and fluorine and, in the case of HCFC's only, one or more chlorine atoms.

20

Examples of HCFC's include chloro difluoromethane (R22) and dichloro trifluoro ethane (R123).

25 Examples of HFC's include 1,1,1,2-tetrafluoroethane (R134a), 1,1,1,2,2-pentafluoroethane (R125), difluoromethane (R-32), 1,1,1-trifluoroethane (R143a) and 1,1-difluoroethane (R-152a). Other components typically found in refrigerant blends may also be included including hydrocarbons, especially hydrocarbons having from 1 to 6 carbon atoms for example propane, isobutane, butane and pentane, fluorinated hydrocarbons and other refrigerants, for example carbon dioxide.

35 When the refrigerant comprises a HFC and especially when the refrigerant consists essentially of a HFC, problems due to blockage of the refrigeration system and in particular the expansion device may be exacerbated.

The present invention is accordingly especially beneficial when the refrigerant comprises an HFC, for example 1,1,1,2-tetrafluoroethane (R134a) or blends of HFC's, for example R407C, R410A and R404A.

5

Various synthetic lubricants are known for use in refrigeration systems for example, polyalkylene glycols (PAGs) and polyol esters. These lubricants are typically used with HFC refrigerants and have a relatively high polarity. The problem of deposition of unwanted residues may also be exacerbated by the use of such lubricants.

Unwanted residues are often non-polar or of high molecular weight, whereas refrigerants comprising HFC's are generally of relatively high polarity and as a consequence the unwanted residue may not be easily solubilised or dispersed in the flow of refrigerant and lubricant.

The invention further comprises a refrigeration system comprising a refrigerant selected from hydrofluorocarbon and hydrochlorofluorocarbon refrigerants, a synthetic ester selected from a polyol ester and a polyoxyalkylene glycol and an anti-deposition component which comprises an amphiphilic compound.

25

A further aspect of the invention provides a refrigeration lubricant composition for use in a refrigeration system with a refrigerant comprising a hydrofluorocarbon which comprises a synthetic lubricant comprising a polyol ester and/or a polyalkylene glycol and an amphiphilic anti-deposition component.

The invention also provides for the use of a lubricant composition comprising a lubricant and an amphiphilic anti-deposition component in a refrigeration system for the inhibition of deposition of deposits which adversely affect the performance of the refrigeration system.

In a further aspect the invention provides a method of inhibiting the deposition of unwanted residues in a refrigeration system which comprises operating a refrigeration system when charged with a hydrogen-containing refrigerant and a lubricant composition comprising a lubricant and an amphiphilic anti-deposition component.

The amphiphilic component must have an optimum balance of amphiphilicity and solubility in order to provide an anti-deposition effect sufficient to reduce or avoid the formation of blockages in the refrigeration system. A measure of the amphiphilicity of the component may be obtained by observing the effect of the component in a standard test as hereinafter defined.

In this test, referred to as the ~~Dispersibility~~ Test~~Dispersibility~~ for convenience, a mixture of 3GS mineral oil, available from Suniso, a neopentyl polyol ester and the amphiphilic component is dispersed in 1,1,1,2-tetrafluoroethane (R134a) and the time for full phase separation of the mixture from R134a is recorded. 50 % by weight of 3GS mineral oil is mixed with 50% by weight of a pentaerythritol ester sold under the trade name EMKARATE RL (grade 32H) available from ICI to form a test oil mixture (TOM). To this TOM, the amphiphilic component is added at a level of 1% by weight based on the weight of the oil mixture to form a homogeneous mixture. The TOM with the amphiphilic component and liquid R134a are then mixed in a ratio of 100 parts TOM to 100 parts R134a and 1 part anti-deposition component by weight at approximately 20°C and agitated vigorously to form a dispersion of R134a with the TOM. The time from which agitation ceases to the formation of 2 distinct clear liquid phases is then measured visually. The time for the distinct phases to form provides an indicative measure of the efficacy of the additive in providing an anti-deposition effect, a longer time for the formation of the distinct phases relative to a

sample without the component being indicative of greater efficacy. It is preferred in the present invention that the phases separate to form two distinct clear liquid phases only after at least 10 seconds, more preferably 30 seconds and even more preferably after at least 1 minute. Especially preferred are those components that delay separation of the phases for at least 3 minutes and most desirably at least 5 minutes. As a reference, a mixture of TOM and R134a without the anti-deposition component separates almost immediately and in any event in less than 5 seconds. It is an essential requirement of the invention that the component does not precipitate from the test mixture and at the concentration employed in the test, at any point during the test.

The anti-deposition component may be any material which meets the criterion of the Dispersibility Test. The component typically has several moieties within the molecule, at least one of which is oleophilic and one of which has a greater affinity for R134a than the oleophilic moiety and which is referred to as a polar moiety.

The anti-deposition component may be cationic, amphoteric, nonionic or anionic.

It is preferred that the component contains, as a polar moiety, an ionisable moiety desirably in ionised form and especially an anionic moiety, or a moiety containing a fluorocarbon group or both an ionisable moiety and a moiety containing a fluorocarbon group. Suitable anionic moieties include sulphate, sulphonate, phosphate and carboxylate and moieties having an active hydrogen. The fluorocarbon group may be any group which contains a carbon atom and a fluorine atom including, by way of example, a hydrocarbyl group wherein at least one hydrogen atom is substituted by a fluorine atom, and optionally all hydrogen atoms have been substituted by fluorine atoms, in other words a group containing exclusively carbon and fluorine atoms for

example trifluoromethyl, pentafluoroethyl  
heptafluoropropyl. Preferably the fluorocarbon group has  
from 1 to 8 carbon atoms, more preferably from 1 to 6  
carbon atoms and especially from 1 to 3 carbon atoms. The  
5 fluorocarbon group may be linear or branched.

Suitable nonionic components include alkyl alkoxylates  
derived from an alkylene oxide and a moiety derivable from  
a compound having an active hydrogen atom and an oleophilic  
10 moiety, for example a long chain alcohol. Preferred  
oleophilic moieties include moieties having an aliphatic  
hydrocarbyl group, for example a hydrocarbyl group having  
from 6 to 22 carbon atoms, an aromatic hydrocarbyl group  
and mixtures thereof. Suitable moieties having an active  
15 hydrogen atom include an alcohol group, an amine group, a  
carboxylic group whether derived from an acid, ester or  
anhydride.

Other suitable nonionic components include esters of  
20 polyalkylene glycols and fluorinated polyethers.

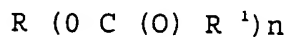
Examples of suitable components include those listed  
in Table 1 below and the classes of compounds to which they  
belong. Especially preferred examples include  
25 dialkylsulphosuccinates and salts thereof, fluoroaliphatic  
polymeric esters and comb graft copolymers of methyl  
methacrylate methacrylic acid and methoxy polyethylene  
oxide methacrylate.

30 The anti-deposition component is suitably present in  
the composition at a level of 0.001 to 5%, preferably 0.01  
to 3% and especially 0.05 to 1% for example 0.5% by weight  
by weight of the lubricant. The component is suitably  
mixed with the lubricant prior to charging to a  
35 refrigeration system. A single anti-deposition component  
or a mixture of such components for example a mixture of an  
anionic component and a nonionic component may be employed  
as desired.

Synthetic lubricants preferred for use in the working fluid compositions of the invention are those selected from the class known as the polyol esters and especially neopentyl polyol esters which have, inter alia, a relatively high level of thermal stability. Suitable neopentyl polyol esters include the esters of pentaerythritol, polypentaerythritols such as di- and tripentaerythritol, trimethylol alkanes such as trimethylol propane, and neopentyl glycol. Such esters may be formed with linear and or branched aliphatic carboxylic acids, such as linear and/or branched alkanolic acids, or esterifiable derivatives thereof, for example anhydrides. A minor proportion of an aliphatic polycarboxylic acid, for example an aliphatic dicarboxylic acid, or an esterifiable derivative thereof may be also used in the synthesis of the ester lubricant in order to increase the viscosity thereof. However, where such an aliphatic polycarboxylic acid (or esterifiable derivative thereof) is employed in the synthesis, it will preferably constitute no more than 50 mole %, more preferably no more than 30 mole %, especially no more than 10 mole % of the total amount of carboxylic acid used in the synthesis. For convenience, the term "carboxylic acid" when employed herein is to be taken to include "esterifiable derivatives" of that acid unless the context clearly precludes this meaning. Usually, the amount of the carboxylic acid(s) used in the synthesis will be sufficient to esterify all of the hydroxyl groups contained in the polyol, but in certain circumstances residual hydroxyl functionality may be acceptable.

A preferred neopentyl polyol ester lubricant is one comprising one or more compounds of the general formula II:

35



II

wherein

R is a hydrocarbon radical remaining after removing the hydroxyl groups from pentaerythritol, dipentaerythritol, tripentaerythritol, trimethylol ethane, trimethylol propane or neopentyl glycol, or the hydroxyl containing hydrocarbon radical remaining after removing a proportion of the hydroxyl groups from pentaerythritol, dipentaerythritol, tripentaerythritol, trimethylol ethane, trimethylol propane or neopentyl glycol;

Each  $R^1$  is, independently, H, a straight chain aliphatic hydrocarbyl group, a branched chain aliphatic hydrocarbyl group, an aliphatic hydrocarbyl group (linear or branched) containing a carboxylic acid or carboxylic acid ester substituent, provided that at least one  $R^1$  group is a linear aliphatic hydrocarbyl group or branched aliphatic hydrocarbol group; and  
 $n$  is an integer.

The aliphatic hydrocarbyl groups specified for  $R^1$  above may be substituted, for example by chloro, fluoro and bromo, and/or may include hetero atoms for example oxygen and nitrogen which may be pendant to the carbon chain or part of the carbon chain of the hydrocarbyl group. Preferably, however, the hydrocarbyl groups contain hydrogen, carbon and optionally oxygen for example in the case where  $R^1$  is an aliphatic hydrocarbyl group containing a carboxylic acid or carboxylic acid ester substituent. It is especially preferred that the hydrocarbyl group contains only carbon and hydrogen atoms.

30

The ester lubricants of Formula II may be prepared by reacting the appropriate polyol or mixture of polyols with the appropriate carboxylic acid or mixture of acids. Esterifiable derivatives of the carboxylic acids may also be used in synthesis, such as the acyl halides, anhydrides and lower alkyl esters thereof. Suitable acyl halides are the acyl chlorides and suitable lower alkyl esters are the methyl esters. Aliphatic polycarboxylic acids, or



esterifiable derivatives thereof, may also be used in the synthesis of the ester lubricant. Where an aliphatic polycarboxylic acid is used in the synthesis of the ester lubricant, the resulting lubricant will comprise one or more compounds of Formula II in which at least one of the R<sub>1</sub> groups is an aliphatic hydrocarbyl group (linear or branched) containing a carboxylic acid or carboxylic acid ester substituent. The ability of polycarboxylic acids to react with two or more alcohol molecules provides a means of increasing the molecular weight of the ester formed and so a means of increasing the viscosity of the lubricant. Examples of such polycarboxylic acids include maleic acid, adipic acid and succinic acid, especially adipic acid. Generally, however, only monocarboxylic acids will be used in the synthesis of ester lubricant, and where polycarboxylic acids are used they will be used together with one or more monocarboxylic acids and will constitute only a minor proportion of the total amount of carboxylic acids used in the synthesis. Where an aliphatic polycarboxylic acid is employed in the synthesis, it will preferably constitute no more than 50 mole %, more preferably no more than 30 mole %, and especially no more than 10 mole% of the total amount of carboxylic acids used in the synthesis, with one or more monocarboxylic acids constituting the remainder.

The amount of the carboxylic acid(s) (or esterifiable derivatives thereof) which is used in the synthesis suitably is sufficient to esterify all of the hydroxyl groups contained in the polyol(s), in which case the resulting lubricant will comprise one or more compounds of Formula II in which R is the hydrocarbon radical remaining after removing the hydroxyl groups from pentaerythritol, dipentaerythritol, tripentaerythritol, trimethylol ethane, trimethylol propane or neopentyl glycol. However, in certain circumstances ester lubricants which comprise residual hydroxyl functionality may be acceptable. Such lubricants comprise one or more ester compounds of Formula

II in which R is the hydroxyl containing hydrocarbon radical remaining after removing a proportion of the hydroxyl groups from pentaerythritol, dipentaerythritol, tripenaerythritol, trimethylol ethane, trimethylol propane  
5 or neopentyl glycol. Esters containing residual (unreacted) hydroxyl functionality are often termed partial esters, and lubricants containing them may be prepared by utilising an amount of the carboxylic acid or acids which is insufficient to esterify all of the hydroxol groups  
10 contained in the polyol or polyols.

The neopentyl polyol ester lubricants may comprise a single compound of Formula II, i.e. the reaction product which is formed between a single polyol and a single  
15 monocarboxylic acid. However, the ester lubricant may also comprise a mixed ester composition comprising two or more single compounds of Formula II. Such mixed ester compositions may be prepared by preparing two or more single esters and then blending those esters together.  
20 Esters utilising two two or more carboxylic acids in the synthesis of the ester will produce an ester having two or more acids within a single compound. These materials are also suitable for use alone or in combination with other single esters or mixed esters. Thus, different mixed ester  
25 compositions, each of which ester has been prepared by utilising two or more polyols and/or two or more carboxylic acids in their synthesis, may also be blended together.

The preferred neopentyl polyol ester lubricants  
30 comprise one or more compounds of Formula II in which R is the hydrocarbon radical remaining after removing the hydroxyl groups from pentaerythritol, dipentaethritol, trimethylol propane or neopentyl glycol. Particularly preferred alcohols for the synthesis of the ester are  
35 pentaerythritol, dipentaerythritol and trimethylol propane.

Preferably, each  $R^1$  in Formula II is, independently, a linear aliphatic hydrocarbyl group or a branched aliphatic hydrocarbyl group.

5 Preferred linear aliphatic hydrocarbyl groups for  $R^1$  are the linear alkyl groups, particularly the  $C_{3-12}$  linear alkyl groups, more particularly the  $C_{5-10}$  linear alkyl groups and especially the  $C_{5-8}$  linear alkyl groups. Examples of suitable linear alkyl groups include n-pentyl, n-hexyl, n-  
10 heptyl, n-octyl, n-nonyl and n-decyl. Esters containing such alkyl groups can be prepared by utilising a linear alkanoic acid (or esterifiable derivative thereof) in the synthesis of the ester.

15 Preferred branched aliphatic hydrocarbyl groups for  $R^1$  are the branched alkyl groups, particularly the  $C_{4-14}$  branched alkyl groups, more particularly the  $C_{6-12}$  branched alkyl groups and especially the  $C_{8-10}$  branched alkyl groups. Examples of suitable branched alkyl groups include  
20 isopentyl, isohexyl, isoheptyl, isooctyl, isononyl, isodecyl, 2-ethylbutyl, 2-methylhexyl, 2-ethylhexyl, 3,3,5-trimethylhexyl, neopentyl, neoheptyl and neodecyl. Esters containing such alkyl groups can be prepared by utilising a branched alkanoic acid (or esterifiable derivative thereof)  
25 in the synthesis of the ester.

In a particular preferred embodiment of the present invention, the ester lubricant comprises one or more esters of general Formula III

30



wherein

$R^2$  is the hydrocarbon radical remaining after removing  
35 the hydroxyl groups from the pentaerythritol, dipentaerythritol or trimethylol propane;

each  $R^3$  is, independently, a linear alkyl group or branched alkyl group; and

p is an integer of 3, 4 or 6,  
wherein one or more of the named polyols, one or more  
linear alkanolic acids or esterifiable derivatives thereof  
and optionally one or more branched alkanolic acids, or  
5 esterifiable derivatives thereof, are utilised in the  
synthesis of the ester lubricant.

Preferably, a mixture of two or more linear alkanolic  
acids, in particular two, or esterifiable derivatives  
10 thereof, are utilised in the synthesis of the ester. More  
preferably, a mixture of one or more linear alkanolic acids,  
or esterifiable derivatives thereof, and one or more  
branched alkanolic acids, or esterifiable derivatives  
thereof, are utilised in the synthesis. Thus, particularly  
15 preferred ester lubricants of the invention are mixed ester  
compositions which comprise a plurality of compounds of  
Formula III.

Where a mixture of linear and branched alkanolic acids,  
20 are utilised in the synthesis with the ester, as is  
preferred, the linear alkanolic acid(s) preferably  
constitutes at least 25 mole % e.g. from 25 to 25 mole %,  
of the total amount of carboxylic acids used. In this way,  
at least 25 mole % e.g. from 25 to 75 mole% of the hydroxyl  
25 groups contained in the polyol or mixture of polyols may be  
reacted with the said linear alkanolic acid(s).

Ester based lubricants comprising one or more  
compounds of Formula III provide a particularly good  
30 balance between the properties desired of a lubricant and,  
in particular good balance between the properties desired  
of a lubricant and, in particular, exhibit good thermal  
stability, good hydrolytic stability and acceptable  
solubility and miscibility with the refrigerant. It is  
35 particular desirable that the lubricant which is used in a  
working fluid composition designed to replace the existing  
compositions based on R-22 and R-502 exhibits good thermal  
stability.

Preferably,  $R^2$  is the hydrocarbon radical remaining after removing the hydroxyl groups from pentaerythritol or dipentaerythritol.

5

Preferred linear and branched alkyl groups for  $R^3$  are those described above in connection with  $R^1$  and are derived by utilising the corresponding alkanolic acids, or esterifiable derivatives thereof.

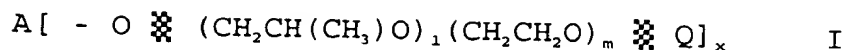
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An especially preferred ester based lubricant comprises an ester based lubricant based on pentaerythritol or oligomers thereof or neopentyl glycol with linear and/or branched acids having from 5 to 10 carbon atoms. Examples  
15 of suitable lubricants include the EMKARATE RL range of refrigeration lubricants available from ICI in particular grades 22H, 32H and 68H. Another especially preferred ester lubricant comprises an ester of pentaerythritol, optionally with up to 10 mole % of dipentaerythritol  
20 (together known as technical grade pentaerythritol) and a mixture of i) linear aliphatic acid having from 5 to 7 carbon atoms, in particular a mixture of pentanoic and heptanoic acids together with ii) a branched aliphatic acid, especially a 9 carbon branched acid. Esterifiable  
25 derivatives of the acids may also be used in the synthesis of the ester.

Suitable polyoxyalkylene glycol lubricants include hydroxyl group initiated polyoxyalkylene glycols, for  
30 example ethylene and/or propylene oxide oligomers initiated on mono alcohols for example methanol and butanol, or polyhydric alcohols, for example, pentaerythritol and glycerol. Such polyoxyalkylene glycols may also be end-capped with suitable terminal groups including alkyl, for  
35 example methyl groups.

A preferred polyoxyalkylene glycol lubricant has an average molecular weight in the range of from about 150 to

about 3000 and comprises one or more compounds of general formula I:



wherein

5        A is the residue remaining after removing the hydroxyl groups from a hydroxyl containing organic compound;  
Q represents hydrogen, an optionally substituted alkyl, acyl, aralkyl or aryl group;

10        1 and m are independently 0 or an integer provided that at least one of 1 or m is an integer, and x is an integer.

The polyoxyalkylene glycol lubricant may be prepared using conventional techniques that are known to those skilled in the art. Thus, in one method, a hydroxyl containing organic compound is reacted with ethylene oxide and/or propylene oxide to form an ethylene oxide and/or propylene oxide oligomer/polymer containing terminal hydroxyl groups. Optionally, this material may then be etherified to produce a polyoxyalkylene glycol of Formula I. The polyoxyalkylene glycol lubricant which is finally formed may comprise a mixture of such compounds which vary from one another in respect of the degree of polymerisation, i.e. the number of ethylene and/or propylene oxide residues. Moreover, a mixture of alcohols and/or phenols may be used as initiators in the formation of the polyoxyalkylene glycol lubricant, and a mixture of etherifying agents which provide different Q groups may also be used. The molecular weight of a polyoxyalkylene glycol lubricant comprising a mixture of compounds of Formula I will represent the average molecular weight of all the compounds present, so that a given lubricant may contain specific polyoxyalkylene glycols which have a molecular weight outside the range quoted above providing the average molecular weight of all the compounds is within that range.

The moiety A in the polyoxyalkylene glycol of Formula I is the residue remaining after removing the hydroxyl groups from a hydroxyl containing organic compound. It is to be understood that this in no way implies that the moiety A need be produced by removing the hydroxyl group. Such compounds include the mono- and polyhydric alcohols and phenols. Where the hydroxyl containing compound which is used as an initiator in the formation of the polyoxyalkylene glycol is a monohydric alcohol or phenol, A is preferably a hydrocarbyl group and more preferably is an alkyl, aryl, alkaryl or aralkyl group, especially alkyl. Suitably alkyl groups for A may be selected from the straight chain (linear), branched or cyclic alkyl groups. Preferably, A is a  $C_{1-15}$  alkyl group, more preferably a  $C_{1-12}$ , particularly a  $C_{1-10}$  and especially the  $C_{1-6}$  alkyl groups. The alkyl group may be linear or branched and straight chain  $C_{1-6}$  alkyl groups are especially preferred. Specific examples of alkyl groups include methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, the various pentyl groups, the various hexyl groups, cyclopentyl, cyclohexyl and the like. An especially preferred alkyl group for A is methyl or n-butyl.

Other suitable hydrocarbyl groups for A are those which remain after removing the hydroxyl group(s) from benzyl alcohol and phenols such as phenol, cresol, nonylphenol, resorcinol and bisphenol A.

Where a polyhydric alcohol is used in the formation of the polyoxyalkylene glycol, A is preferably a hydrocarbon radical. Suitable hydrocarbon radicals for A are those which remain after removing the hydroxol groups from polyhydric alcohols such as ethylene glycol, propylene glycol, 1,4-butanediol, 1,6-hexanediol, diethylene glycol, dipropylene glycol, neopentyl glycol, cyclohexane dimethanol, glycerol, 1,2,6-hexane triol, trimethylolpropane, pentaerythritol, dipentaerythritol and sorbitol. A particularly preferred hydrocarbon radical for

A is that remaining after removing the hydroxyl groups from glycerol.

The moiety Q in the polyoxyalkylene glycol of Formula I is H, an optionally substituted alkyl, aralkyl or aryl group. A preferred optionally substituted aralkyl group for Q is an optionally substituted benzyl group. Preferred optionally substituted aryl groups for Q include phenyl and alkyl substituted phenyl groups. Preferably, Q is an optionally substituted, for example halogen substituted, alkyl group, particularly an optionally substituted C<sub>1-12</sub> alkyl group and more particularly an optionally substituted C<sub>1-4</sub> alkyl group. Suitable alkyl groups for Q may be selected from, the straight chain (linear), branched or cyclic alkyl groups especially the linear alkyl groups. Although the alkyl groups for Q may be optionally substituted, they are preferably unsubstituted, Accordingly, particularly preferred alkyl groups for Q are selected from methyl, ethyl, propyl, isopropyl and the various butyl groups. An especially preferred alkyl group for Q is methyl.

The polyoxyalkylene glycol of Formula I may be a polyoxyethylene glycol, a polyoxypropylene glycol or a poly(oxyethylene/oxypropylene) glycol in the latter case, the ethylene oxide and propylene oxide residues may be arranged randomly or in blocks along the polymer chain Preferred polyoxyalkylene glycols are polyoxypropylene glycols and the poly(oxyethylene/oxypropylene) glycols.

30

The lubricant composition may also comprise one or more of the additives which are conventional in the refrigeration lubricants art. Specific mention may be made of oxidation resistance and thermal stability improvers, corrosion inhibitors, metal deactivators, viscosity index improvers, anti-wear agents and extreme pressure resistance additives. Such additives are well known to those skilled in the art. Where the lubricant is part of a lubricant

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composition containing one or more additives, such additives may be present in the amounts conventional in the art. Preferably, the cumulative weight of all the additives will not be more than 8%, e.g. 5% of the total weight of the lubricant composition.

Suitable oxidation resistance and thermal stability improvers may be selected from the diphenyl-, dinaphthyl-, and phenylnaphthyl-amines, the phenyl and naphthyl groups of which may be substituted. Specific examples include N,N'-diphenyl phenylenediamine, p-octyldiphenylamine, p,p-di-octyldiphenylamine, N-phenyl-1-naphthyl amine, N-phenyl-2-naphthyl amine, N-(p-dodecyl)-phenyl-2-naphthyl amine, di-1-naphthyl amine, and di-2-naphthyl amine. Other suitable oxidation resistance and thermal stability improvers may be selected from the phenothiazines such as N-alkylphenothiazines, and the hindered phenols such as 6-(t-butyl) phenol, 2,6-di-(t-butyl) phenol, 4-methyl-2,6-di-(t-butyl) phenol and 4,4'-methylenebis(-2,6-di-[t-butyl] phenol).

Suitable cuprous metal deactivators may be selected from imidazole, benzamidazole, 2-mercaptobenzthiazole, 2,5-dimercaptothiadiazole, salicylidine-propylenediamine, pyrazole, benzotriazole, toluotriazole, 2-methylbenzamidazole, 3,5-dimethyl pyrazole, and methylene bis-benzotriazole. Examples of more general deactivators and/or corrosion inhibitors include organic acids and the esters, metal salts and anhydrides thereof, such as N-oleyl-sarcosine, sorbitan monooleate, lead naphthenate, dodecenyl-succinic acid and its partial esters and amides, and 4-nonylphenoxy acetic acid; primary, secondary and tertiary aliphatic and cycloaliphatic amines and amine salts of organic and inorganic acids, such as oil soluble alkylammonium carboxylates; heterocyclic nitrogen containing compounds, such as thiadiazoles, substituted imidazolines, and oxazolines; quinones and anthraquinones; ester and amide derivatives of alkenyl succinic anhydrides

or acids, dithiocarbarnates, dithiophosphates; and amine salts of alkyl acid phosphates and their derivatives.

Suitable viscosity index improvers include  
5 polymethacrylate polymers, copolymers of vinyl pyrrolidone and methacrylates, polybutene polymers, and copolymers of styrene and acrylates.

Examples of suitable anti-wear and extreme pressure  
10 resistance agents include sulphurised fatty acids and fatty acid esters, such as sulphurised octyl tallate; sulphurised terpenes; sulphurised olefin; organopolysulphides; organo phosphorous derivatives including amine phosphates, alkyl acid phosphates, dialkyl phosphates, aminedithiophosphates,  
15 trialkyl and triaryl phosphorothionates, trialkly and triaryl phosphines, and dialkylphosphites, e.g. amine salts of phosphoric acid and monohexyl ester, amine salts of dinonylnaphthalene sulphonate, triphenyl phosphate, tripaphthyl phosphate, diphenyl cresyl and dicresyl phenyl  
20 phosphates, tricresyl phosphate, naphthyl diphenyl phosphate, triphenylphosphorothionate; dithiocarbonates, such as an antimony dialkyl dithiocarbamate; chlorinated and/or fluorinated hydrocarbons and xanthates.

25 The invention is now described by way of non-limiting example.

#### Example 1

30 A series of test mixtures were produced by mixing 10g of EMKARATE RL (supplied by ICI) Grade 32H with 10g of 3GS mineral oil available from Suniso and 0.2g of the anti-deposition component as listed in Table 1 below. This mixture was then added to 20g R134a and subjected to the  
35 Dispersibility Test set out above. The time for the materials to separate was then measured and the results are shown in Table 1.

Table 1

Anti ✕ Depositon                      Supplier                      Separation Time  
Component

SPAN 85	ICI	15 s
SPAN 80	ICI	25 s
FC430	3M	90 s
FC431	3M	10 s
ZONYL FSJ	Aldrich	30 s
ZONYL FSP	Aldrich	10 s
ZONYL FSA	Aldrich	10 s
TRITON X-100	BDH	20 s
TWEEN 20	ICI	10 s
TWEEN 60	ICI	25 s
SURFYNOL SE	Lancaster	15 s
Diocylsulfosuccinate	Lancaster	>5 mins
HYPERMER CG6	ICI	10 s
TWEEN 80	ICI	20 s
SPAN 80	ICI	10 s
SYNPERIONIC 91/6	ICI	10 s
ATLAS G1284	ICI	30 s
SYNPERONIC A7	ICI	10 s
ZONYL FSE	Aldrich	15 s
Dodecylbenzenesulphonic acid	Aldrich	>5 mins
Dodecylsulphate	Aldrich	25 s
Lauryl acrylate	Lancaster	15 s
Allyl stearate	Lancaster 20s	20 s
2-hydroxyhexadecanoic acid	Lancaster	35 s

Claims

1. A lubricant composition comprising a lubricant and an amphiphilic anti-deposition component.
2. A refrigeration lubricant composition for use in a  
5 refrigeration system with a hydrogen-containing refrigerant comprising a synthetic lubricant and an amphiphilic anti-deposition component.
3. A refrigeration lubrication composition for use in a refrigeration system with a refrigerant comprising a  
10 hydrofluorocarbon which comprises a synthetic lubricant comprising a polyol ester and/or a polyalkylene glycol and an amphiphilic anti-deposition component.
4. A refrigeration system comprising a refrigerant selected from hydrofluorocarbon and hydrochlorofluorocarbon  
15 refrigerants, a synthetic ester selected from a polyol ester and a polyoxyalkylene glycol and an anti-deposition component which comprises an amphiphilic compound.
5. Use of a lubricant composition comprising a lubricant and an amphiphilic anti-deposition component in a  
20 refrigeration system for the inhibition of deposition of deposits which adversely affect the performance of the refrigeration system.
6. A method of inhibiting the deposition of unwanted residues in a refrigeration system which comprises  
25 operating a refrigeration system when charged with a hydrogen-containing refrigerant and a lubricant composition comprising a lubricant and an amphiphilic anti-deposition component.